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PAIR OF TUSI AND LEMMA URDI IN THE MODEL AT COPERNICUS

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ABSTRACT

The article deals with the fact of reticence of Nicolaus Copernicus about using the mathematical basis - Maragha Revolution by him in "his" astronomy.

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INTRODUCTION

The name Nasir al-Din al-Tusi (Abu Jafar Muhammad ibn Muhammad Nasir al-Din al-Tusi (1201-1274)) is among the coryphaeus of the world science. He is called as the scientist – Encyclopaedist. Tusi is the author of works on philosophy, theology, economics and law,as well as mathematics, astronomy, physics, mineralogy, music theory and other natural - scientific disciplines. Though then subspecialty didn't stand out. The scientist had to understand all areas of science. Not everyone could be embedded enough in these branches of science. Establishment of the observatory was one of the decisive moments both in the creative life of Tusi and the history of science. An astronomic observatory was built near Maragha under the leadership of Nasir al-Din al-Tusi underHulagu Khan's sway in 1259-60. Maragha observatory was the largest of its time. It consisted of several buildings occupying an area of 150 meters in width and 350m in length. There was a large library of 400,000 books collected from Persia, Syria, Mesopotamia. It had its own universitywhere more than hundred students studied. Tusi sought to create able-bodied staff in the observatory and managed the set task perfectly. Then he was already a famous scientist. The fame of an outstanding scientist helped him in many things. Nasir al-Din al-Tusihad been acquainted personally with many astronomers of that time till the construction of the observatory and could choose future employees. Besides its astronomers, scientists, engineers from other cities and countries were invited to Maragha. They were prominent experts; Muayyad al-Din al-Urdi from Damascus, Fakhr al-Din al-Maraghafrom Mosuk, Fakhr al-Din al-Ihlati from Tiflis, Naji al-Din al-Debirani from Gazvin, FaoMun Chi from China, Shams ad-Din al-Samarkand from Samarkand and others. Muayyad al-Din al-Urdi (Muayyad al-Din al-Muayyad ibn Barmak Ibn al-Mubarak al-Amir al-Urdi Dimashqi (um.1266)) was born in Aleppo (Siriya today), worked in Maragha Astronomical Observatory of Nasir al-Din al-Tusi. Urdi was an extremely popular figure in his era. in Damascus He had worked as an architect before coming to Maraga at the invitation of Tusi and developed the city waterworks as the future engineer. Urdi designed and carried out the construction of Maragha observatory together with Nasir al-Din al-Tusi. He was not only one of the major astronomers, but also the chief architect of Maragha observatory, designer of its astronomical instruments. His work on astronomical instruments of Maragha observatory exerted great influence on development of astronomical instrumentation in the observatories of Ulugbek, Tycho Brahe, observatories in Jaipur. His son Muhammad Muayyad al-Din al-Urdi also worked at Maragha observatory. The stellar globe composed by him survived to our days (since 1562 in Dresden, Germany). This globe is essentially a star

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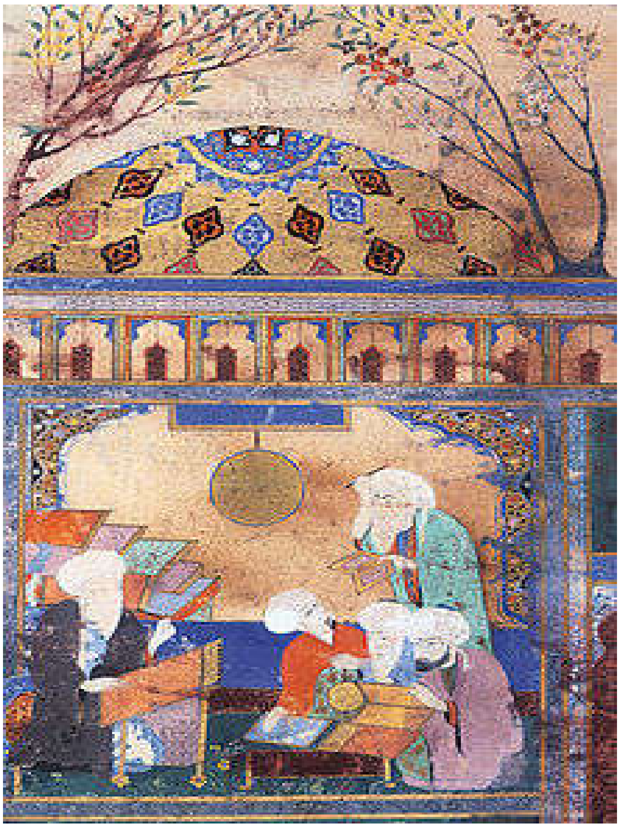
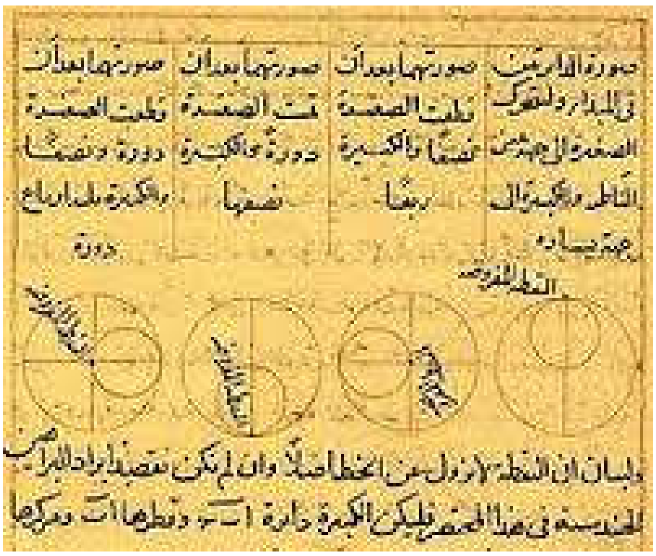
catalog of the brightest stars. It was possible to determine the date of manufacture of the globe upon the position of the stars.
Muayyad al-Din al-Urdi constructed five astronomical instruments of completely new design and five-old ones under the direct leadership of Nasir al-Din. Information about the astronomical instruments that used in Maragha observatoryare available in a single written source written by Muayyad al-Din in Arabic. According to Muhammad Ali Taribiyata one copy of the work of Urdi is stored in Tehran library. One the latter copies was found at the beginning of the last century in Paris National Library, it is stored among the Arabic manuscripts under №1156. This copy is removed from older one. This work was translated into Germany (1928) and French (1810) languages. Astronomical instruments of Maragha observatory were made of this size that the observations of its superior accuracy overpassed the observations of previous observatories. Among the astronomical instruments The tools of Maragha observatory were of completely new constructions among the astronomic instruments. "The Book on Astronomy» (Kitab fi-l-hay'a) Muayyad al-Din al-Urdi. Translated into French by A.Jourdain Paris National Library. It is necessary specially to allocate the rotating quadrant which contributed to conduct extrameridional monitoring of luminaries and to increase significantly the number of observations and their accuracy. The astronomical instruments of Maragha observatory have been used in many observatories around the world in the future. The observatories in Tabriz (XIII), Beijing (XIII), Samarkand (XIV) observatory in Tycho Brahe (XVI) and otherobservatories shall be noted specially.



The rotating quadrant invented and installed in Maragha observatory turned into a universal toolin its further development and improvement. Thus, the rotating quadrant is the prototype of the universal tool. The merits of Tusi determined the European Renaissance for centuries. 150 scientific papers of the king of science are known to us. He was called so then. Physics is based on empirical and mathematical physics. "Maragha Revolution" that connects mathematics to the real world is separated out specially in the world scince. "Maragha Revolution" is characterized by the transition from the philosophical foundations of Aristotelian cosmology and astronomy of Ptolemy to empirical observations and mathematization of astronomy and nature in general. Ptolemy advocated the use of observations for verification of the models of the space. The Islamic astronomers accepted his advice very seriously. As the basis, an important aspect of "Maragha Revolution" was the following: astronomy shall be directed to the description of the behavior of physical bodies in mathematical language and shall not remain as a mathematical hypothesis without its real action.

"Problems of equant" in the system of Ptolemy attracted attention of the astronomers of Maragha observatory in the XIII century. It was necessary to create not the Ptolemaic mathematical model taking into account the physical properties of celestial spheres, corresponding observable celestial movements. The astronomers of Maragha have tried to solve the problem of equant and to produce alternative configurations of Ptolemy's models. This issue was settle by Urdiand Tusi putting forward "Tusi couple", and Lemmu Urdi. The astronomers of Maragha were more successful and accurate in forecasting numerical position of the planets which were in better agreement with the empirical observations. The astronomers of Maragha certified that cosmic motion was circular. The first empirical observations witnessing the rotation of the Earth's around its axis were explained by Tusi. None Ptolemaic model which is identical mathematically to the heliocentric model of Copernicus is one of the wonderful achievements of Tusi’s school. Urdi was the first astronomer of Maragha who developed the Ptolemaic model in 1250 and suggested a new theory of Lemmu Urdi. Tusi settled serious problems in the system of Ptolemy. He invented the geometrical technique called "Pair of Tusi" in 1247 for planetary model which generates linear movement of the sum of two circular motions. Developing "pair of Tusi" as an alternative physical problem equant introduced by Ptolemyhe created a plausible model for empirical orbits. "Pair of Tusi" is the astronomical master piece of Tusi created in 1261 - a mathematical statement of the physical movements of the planets. According to this model, as noted above, the rotational motion is converted into linear.



“pair of Tusi”

The apprentice of Tusi Gutb al-Din al-Shirazi (um.1311) discussed the possibility of heliocentrism. Lemma Urdi and pair of Tusi were used in the geocentric model of Ibn al-Shatyr (um.1375) and later in the heliocentric model of Nicolaus Copernicus (1473-1543). The researchers of the solar system of Copernicus believed that he improved Ptolemaic system placing the point of observation of the heavens from Earth on a firmer mathematical foundation. Only then Copernicus could transport the entire system from its geocentric base to the Sun. It was a simple operation that required Copernicus to change the direction of the vector connecting the Earth to the sun. The rest part remained mathematically the same. It was assumed that Copernicus was able to create a new planetary system using available math. It was believed that "Copernican revolution" depended on the creative ability of the new application of classical Greek works (Euclid, Ptolemy). This assumption was destroyed by the end of the 50s years of the twentieth century. Such scholars - historians of science like as Otto Neugebauer, Edward Kennedy, George Saliba began to review the math of Kepler. They found that a revolution in the astronomy of Kepler did two essential theorems not developed by the ancient Greeks. The scheme itself of Ptolemy is physically impossible. The problem is the lack of Equant.

Neugebauer had a question: did Copernicus develop these two theorems himself or borrow from anyGreek labor? Meanwhile, Kennedy working in Beirut discovered astronomical papers written in Arabic and dated 1350. These documents contained unfamiliar geometry. During his visit to US, he showed them to Neugebauer. These works were interesting for the last person. They contained geometry, identical models to the Copernican model about the motion of the moon. The text was written by the astronomer Ibn al-Shatyr (dies in 1375). Besides others, "Copernican theorem" was able in his workwhich was developed 300 years before Copernicus by the famous astronomer Nasir al-Din al-Tusi. "Pair of Tusi", as this theorem is called, solvescenturies-old problem suffered by Ptolemy and many other Greek scientists - astronomers. This theorem is about how the circular motion can generate linear motion. The motion of the two spheres is considered here. Twice smaller ball is placed in a larger bowl. They are both in motion, but in the opposite direction. The smaller ball rotates within the larger one. "Pair of Tusi" dictates that the starting point of contact of these balls will oscillate back and forward along the diameter of a large sphere. Having established the celestial spheres properly, this theorem explains how the epicycle could move uniformly around the equant different and still varies back and forward to the direction of the different point.

The second theorem found in the Copernican system is Lemma Urdi launched in 1250. Great part of the scientific knowledge about the ancient world of Greece, Babylon, Egypt, India and China, the Muslim science was tunnelized to the West through Spain. The European scientists were interested in all Arabic documents. These are translations of Greek works, Arabic originals, Arabic translations of manuscripts of other cultures. George Saliba found that scientific work written in Arabic are in the European librariesnowwhere all the scientific thoughts and works of the medieval period are concentrated. The researcher says that many European scientists knew Arabicduring Renaissance. The European scientist William Harvey studied in Padua. He "established" the geometry of the human blood circulation in 1629. As indicated bySaliba, there is the Arabic manuscript written by the Damascus physician Ibn al-Nafis (died in1288)in 1241where the geometry of the blood circulation is stated affirming and explaining every point scheme that solves some problematic issues of the past medicine and refusing not satisfying views of the ancient Greek physician Galen. Here is an example, Copernicus also studied in Padua. According to George Saliba, both "Pair of Tusi" and Lemma Urdi are "partially embedded in the astronomy of Copernicus so much as that it would be inconceivable to remove them and to leave mathematical constructions of astronomy of Copernicus intact." Any geometric theorem has different points with the letters or numbers at the discretion of the originator. The order and the selection of symbols is arbitrary. German historian of science Willy Hartnerstated that geometric point used by Copernicus were identical to the original notations of al-Tusi. That is to say that the point marked by the symbol "Alif" by Tusi was Amarked by Copernicus. Arabic "Ba" was marked as – B and so on. All points of Copernicusare phonetic equivalents of the Arabic alphabet (language). There was one weak exception. The center of the smaller circle in the diagram of Tusi is Z and of Copernicus is F. Although in the Arabic Z (writing letter) is lightly similar to (F).

The second "new" theorem of Copernicus Lemma Urdi has no evidence of it. Johannes Kepler stretched out circular orbits of the planet of Copernicus in ellipses at the near the end of the XVI century and asked proof of 'new' theorem from Copernicus but remainedwithout answer. It is necessary to accept that the new mathematics in the Copernican revolution occurred first not from the European but from the Islamic mind. Historians of science ask a question: why doesn't Copernicus recognize the use of the works of Muslim scholars? And they get a logical answer to certain extent:At that time the Ottoman Empire was at the gates of Europe, in these circumstances, it wouldn't be appropriate to call the ideas and achievements of Islamic scholars. Europehaditsown "pride". One of the versions of the answer to the question: how did Copernicus get the works of Tusi? There is the fact that a Latin translation of the works of Tusi was found in Italy. Copernicus spent a lot of time in Italy where he could read the manuscript. (Approx. J. Saliba). The Criticism of Tusi Ptolemy about the physical nature of the Earth was similar to the arguments later used by Copernicus to protect the rotation of the Earthin 1543. Tusi wrote about the true nature of the Milky Way that the Milky Way - the galaxy contained large number of small, closely spaced stars that seem to be clouds in the milky color because of their concentration and smallness. Three centuries later in 1610 it was stated again by Galileo using a telescope. The model of the Moon and Mercury prepared by the Syrian astronomer Ibn al-Shatir was also in the book of Copernicus. Tusi developed a special geometric design in connection with the V postulate of Euclid, which was used by John Wallace in his studies in England (1703). Subsequently, this method was used by Saccheri (1733), but neither of them called Tusi. In 1957 it failed to demonstrate that the theorems of Tusi and Urda, the model of Moon of Ibn al-Shatir was used by Copernicus under the name his own astronomy and was considered as the Copernican revolution published in 1543. Hegel actually said the right words: "If there wasn't East, West wouldn'tbe either".

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